

Perception of pain as a result of orthodontic treatment with fixed appliances

Philipp A. Scheurer, Allen R. Firestone and Walter B. B rigin

Department of Orthodontics, University of Bern, Switzerland

SUMMARY The aims of this study were to investigate the intensity, location and duration of patients' discomfort following insertion of orthodontic appliances, and to examine for interactions between patient age, gender, appliance type and the perception of pain. After insertion of orthodontic appliances, 170 patients received eight questionnaires, one they completed and returned after 4 h, then one daily for 7 days. The respondents' ages ranged from 8–53 years (median age 13 years 7 months); 45 per cent were male and 55 per cent female. Of the patients, 65 per cent reported pain after 4 h and 95 per cent after 24 h. After 7 days, 25 per cent of the patients still reported discomfort. Patients' pain intensity scores were significantly higher for the anterior than for the posterior teeth. On day 1, 16 per cent took analgesics and 18 per cent reported being awakened the first night. Comparing a 2 × 4 appliance, a full appliance in one arch and in both arches, no statistical differences were found for reported pain frequency, general intensity of pain, pain at the teeth, discomfort when biting and chewing and analgesic consumption. The perception of general pain intensity, analgesic consumption, pain when eating and the influence of discomfort on daily life were all significantly greater in girls than in boys. Patients younger than 13 years reported pain significantly less frequently than the older patients. The highest frequency of pain was found in the group of 13–16 year olds. The pain intensity did not differ among the age groups.

Introduction

Orthodontists must be able to address the concerns of the patient about their treatment. Pain and discomfort are frequent side-effects of orthodontic therapy with fixed appliances. The orthodontist should be able to inform the patient about this common side-effect of treatment, especially before inserting an appliance that will cause discomfort. In most cases, the level of pre-treatment explanations seems to be generally satisfactory, but many people report not having been well-informed (Oliver and Knapman, 1985).

The mechanisms whereby the application of orthodontic forces cause pain are not yet fully understood, but there are indications that these perceptions are due to changes in blood flow in the periodontal ligament (Burstone, 1964; White, 1984; Kvam *et al.*, 1987) and correlated with the presence of prostaglandins, substance P and other substances (Burstone, 1964; White, 1986; Kvam *et al.*, 1987; Ngan *et al.*, 1994).

The subjective perception of pain is difficult to measure and there is a wide range of individual response even when similar forces are applied to teeth (Burstone, 1964). Several studies have described patients' responses to fixed orthodontic appliances. These studies report that pain begins a few hours after application of an orthodontic force and lasts approximately 5 days (Jones, 1984; Jones and Richmond, 1985; Sinclair *et al.*, 1986; Feinmann *et al.*, 1987; Kvam *et al.*, 1987, 1989; Ngan *et al.*, 1989; Wilson *et al.*, 1989; Jones and Chan, 1992). There is less unanimity about the question of how fast pain starts and whether or not the force magnitude, the sex and the age of the patient influence the outcome of pain reports. This may be due to differences in the experimental design, e.g. reporting methods, the number and schedule of questionnaires and the size of the sample groups and subgroups.

The aim of the present study was to investigate the intensity, location and duration of patients' pain following the insertion of ortho-

dontic appliances. Further aims were to examine for interactions between the age and gender of the patient and the perception of pain and between the kind of appliance and the perception of pain. It was also an aim of this study to investigate the effect that pain, as a consequence of orthodontic treatment, had on the subject's daily life.

Subjects and methods

This study describes the response of patients who were at the beginning of their active treatment. After insertion of a fixed appliance, 170 patients received a series of eight questionnaires. They were requested to complete one and mail it back after 4 h, 24 h, 2, 3, 4, 5, 6 and 7 days. The mean age of the respondents was 15 years 7 months with a median value of 13 years 7 months (range 8–53 years). Of the participants, 77 (45.3 per cent) were male and 93 (54.7 per cent) female. All the subjects came from the area around Bern or Basel, Switzerland. They were either patients of the Department of Orthodontics at the School of Dentistry, University of Bern, or of a private practice in Basel. The patients were not pre-selected but were a convenience sample of consecutive cases.

The appliances inserted were either complete banded/bonded appliances in one arch ($n=52$) or in both arches ($n=98$), or partial banded/bonded appliances, i.e. 2×4 ($n=10$) in one arch, or a Goshgarian transpalatal appliance ($n=10$). Jones *et al.* (1985, 1992) could find no difference in discomfort following the insertion of different aligning arch wires, and we did not include the type of archwire as a parameter in the study. There were several different dentists who performed the treatments but they all had the same materials available and in most of the cases the first wire was a 0.016 in nitinol. The initial space-analysis or anterior crowding were not recorded: Jones and Richmond (1985) concluded that there was no relationship between pain experience and initial crowding.

The patients were given oral and written instructions together with an explanation on how to complete the questionnaires. The questionnaires consisted of 25 questions. Three questions had to be answered by choosing 'yes' or 'no'. All the other questions used a visual analogue scale (VAS). This method is widely used for measuring pain and has been described by

other investigators as being sensitive and reliable and having certain advantages over verbal scales (Huskisson, 1974; Seymour *et al.*, 1985). Moreover, even small children manage it very well (Huskisson, 1974; Seymour *et al.*, 1985).

The data were analysed by a commercial software program (SAS; SAS-Institute, Cary, NC, USA). Cross tabulations were worked out and the significance of the dependence between parameters was calculated. The chi-square test, Wilcoxon test and Fisher's exact test were applied where appropriate. The level of significance was set at $P < 0.01$.

Results

Pain course

The response rate was excellent: 97 per cent for day 5 and earlier, 85 per cent for the last questionnaire (day 7) and 95 per cent overall for all questionnaires. The pain course during the observation time of 7 days was established by counting the number of patients who reported 'yes' when asked: 'Did it hurt within the last 24 h (4 h for the first questionnaire)?' (yes/no) and measuring the response to the question 'How much does it hurt NOW?' (VAS). Table 1 and Figure 1 show the number of answers 'yes' as well as the pain score for those who responded 'yes' (100 being the maximum pain response and 0 no pain).

Within 4 h after insertion of the appliance, almost two-thirds of the patients reported experiencing discomfort, almost every patient (94 per cent) reported pain from the appliance within the first 24 h. After this peak, the number of patients reporting pain decreased steadily. The percentage of patients who experienced pain was still very high on the second day (85 per cent) and even on the last scoring day (7) one out of four patients reported having had discomfort from the appliance.

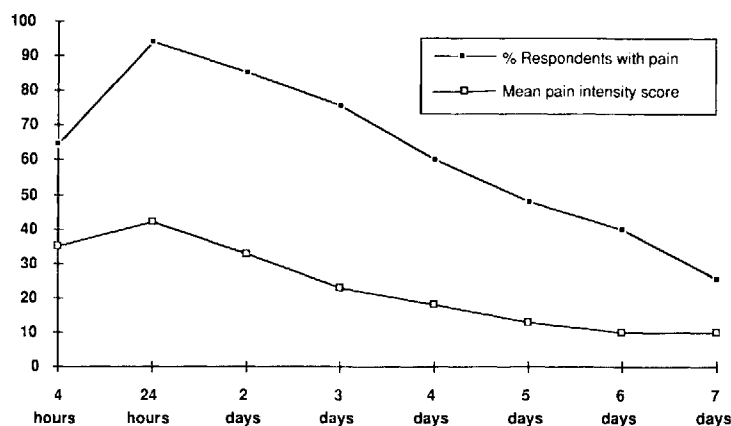
For pain intensity scores, the peak occurred at 24 h. Several patients reported the pain as being unbearably strong (score 100), but the mean score of 42 was relatively moderate. Pain intensity score was at about the same level after 4 h and at day 2. Until day 4, the range of responses was from 0 up to 100 and the mean score was higher than 15. After 5 days, the mean pain score was below 15 and the highest response was only 58.

The time course for the number of respond-

Table 1. Number of patients with pain within the last 24 h ('yes') and pain score of 'yes' responders.

Time after insertion	N total responses	N responses 'yes'	% total responses	Mean pain intensity score for 'yes'	Range of pain score (pain now)
4 h	170	110	64.7	35	0-100
24 h	167	157	94	42	0-100
2 days	164	140	85.4	33	0-100
3 days	165	125	75.8	23	0-100
4 days	166	100	60.2	18	0-100
5 days	162	78	48.1	13	0-58
6 days	153	61	39.9	10	0-48
7 days	145	37	25.5	10	0-49

0 = no pain; 100 = maximum pain.

**Figure 1** Percentage age of respondents experiencing pain within a reporting period (—■—) and mean pain intensity score (---□---).

ents reporting pain and the mean pain intensity score are given in Figure 1. Both the number of patients experiencing pain and the pain intensity peaked at 24 h and diminished steadily over the remainder of the reporting period.

Analgesic consumption

Neither prescriptions for pain medication nor analgesics were dispensed to the patients. Every patient was free to take any medication he or she felt necessary. Patients were asked to respond whether or not they had taken any analgesics within the last 24 h. The percentage of 'yes' answers increased from 7.1 per cent after 4 h to 16.2 per cent after 24 h and fell to 13 per cent after 48 h and 4.2 per cent or less after day 3. On the seventh day, no patient reported taking medication for pain relief.

Pain sites

There was a group of questions designed to elicit information about the pain intensity by site and activity. During the whole time of observation, no pain intensity score higher than 15 was found at the following locations: gums, lips, tongue, face, temporomandibular joint (TMJ), nor for pain when speaking, headache and pain at rest. All these pain intensity scores showed the same curve as the general pain curve, having a peak at 24 h with a decrease thereafter.

At the other sites and for the activities 'biting' and 'chewing', reported pain intensity peaked at 24 h after insertion of fixed appliances with relatively high scores and remained high during the second day (Table 2). Although means for reported discomfort at the cheeks and ulcerated

Table 2. Mean pain intensity scores of different sites and of the activities 'biting' (incising) and 'chewing'. Number of respondents is given in parentheses.

Time after insertion	Checks	Ulcerated sites	Anterior teeth	Premolars and molars	Biting	Chewing
4 h	12 (107)	14 (106)	34 (109)	23 (109)	53 (104)	52 (104)
24 h	17 (149)	22 (146)	46 (154)	27 (152)	67 (145)	60 (146)
2 days	19 (137)	29 (138)	41 (139)	26 (137)	66 (137)	57 (137)
3 days	16 (122)	26 (122)	29 (123)	17 (122)	51 (119)	42 (121)
4 days	14 (98)	20 (98)	21 (100)	11 (98)	45 (95)	35 (96)
5 days	15 (75)	18 (73)	18 (77)	12 (76)	39 (74)	27 (74)
6 days	9 (57)	12 (57)	14 (59)	5 (58)	29 (56)	20 (57)
7 days	11 (36)	10 (36)	9 (37)	5 (37)	21 (34)	15 (35)

sites did not reach extremely high levels, it is of note that the peak intensity was reached at the second day and that there was not much relief over time (Table 2).

Even without chewing or biting, in general the anterior teeth were more painful than premolars and molars ('back teeth'). The most painful activity after insertion of fixed appliances was reported to be biting-off (incising) food: the highest pain intensity recorded was from this activity. Incising was reported to be slightly more painful than chewing at every time interval. Both biting and chewing provoked very high pain intensity scores quickly. After only 4 h, mean pain intensity scores exceeded half of the VAS-length and remained there up to day 3.

Pain course during the day/night

In all, 18 per cent of the patients reported being awakened because of pain in the first night after the insertion of the appliances. This fell to 10 per cent for the second night and was between 1.2 per cent and 3.6 per cent during the other nights of observation. During the whole time of observation, pain score was clearly lower in bed than during the day. The peak mean value reported for pain intensity when falling asleep (26), was reached after the first night, and fell to 10 and less after day 3. For patients reporting pain, even at the first 24 h response, the mean score for the perception of the change in pain during the day (55), indicated that pain was perceived as improving during the day. The perception, for patients reporting pain, that pain decreased during the day became stronger with each reporting period. Thus, despite biting and chewing during the day, discomfort did not increase.

Influence on daily life

The insertion of fixed appliances seems to have had only a minor effect on our patients' daily life (Table 3). Like pain intensity scores, influence on daily activities in general reached a peak after 24 h. From the third day on the mean score was below 15. As biting and chewing were seen to be the most painful activities, eating seemed to present the greatest problem in daily life. Mean scores of 49 after 4 h, 60 after one day and 52 after two days indicate a significant and pervasive influence on eating habits. On day 5 a mean score of 29 indicates that many patients still had to eat a modified diet. As far as leisure activities and social life is concerned, the mean score never exceeded 15.

There were 21 wind instrument players in the study and they were not separated into subgroups as flutists, trumpet players etc. In response to the question about how much the appliances interfered with practising the instrument, with score 100 for 'practice impossible' and scoring 0 for 'no interference with practice', the results in Table 3 indicate that it took 1 week until the appliance no longer interfered with practice.

Type of treatment

To measure whether or not the type of appliance had an influence on the discomfort level, the complete banded/bonded appliance in both arches served as a reference.

Goshgarian Patients having a Goshgarian transpalatal arch inserted, which was activated to rotate maxillary molars, reported pain with a significantly lower frequency than patients who were fully banded/bonded, but the mean pain intensity score did not differ between the two groups. Anterior teeth hurt less, but poster-

Table 3. Mean scores of patients who marked a response for the effect of the fixed appliances on their daily activities. Number of respondents is given in parentheses.

Time after insertion	Infl. on daily life in general mean scores	Infl. on eating habits (more soup, eggs etc.)	Infl. on leisure activities (sports etc.)	Infl. on social life (meeting friends etc.)	Exercise with wind instrument
4 h	16 (101)	49 (104)	10 (102)	—	—
24 h	21 (135)	60 (134)	13 (134)	5 (134)	31 (21)
2 days	19 (134)	52 (132)	10 (132)	6 (132)	37 (21)
3 days	12 (111)	44 (111)	8 (111)	4 (111)	28 (21)
4 days	11 (88)	35 (88)	7 (86)	3 (86)	31 (15)
5 days	9 (70)	29 (70)	7 (70)	5 (70)	31 (12)
6 days	5 (53)	26 (53)	5 (53)	2 (53)	20 (10)
7 days	7 (32)	11 (32)	3 (32)	2 (32)	1 (5)

ior teeth hurt more compared with complete appliances; both findings were statistically significant. Goshgarian appliances interfere with wind instrument practice significantly less than brackets on all the teeth. All the other parameters, including 'chewing' did not differ significantly.

Complete appliance in one arch and 2 × 4 Patients with brackets only on the incisors (2 × 4) reported less influence on diet i.e. avoiding hard things to eat, restricting meals to eggs, soup etc. than patients with appliances in both arches. For both appliances there was no statistical difference, compared with a complete appliance, for pain frequency, reported intensity of pain or for activities such as chewing, biting and leisure activities (with the exception of wind instrument playing). Also the frequency of analgesic consumption did not differ among the appliances.

Sex

For three parameters: frequency of pain, pain intensity for the anterior teeth and influence on leisure activities, there was no difference between the sexes. For all the other variables, statistically significant differences were found, with females reporting a greater perception of discomfort for pain intensity, for pain in posterior teeth and TMJ, for chewing and biting as well as for reported interference with daily life. In accordance with these reports of greater discomfort, female subjects also reported a significantly higher analgesic consumption frequency ($P < 0.001$). The only exception to higher female ratings was the influence of treatment on exercise with wind instruments. Here,

male patients reported greater ($P < 0.001$) impediments from orthodontic appliances.

Age

The patients were separated according to age into three groups: 10–13 years ($n = 55$), 13–16 years ($n = 71$) and > 16 years ($n = 36$). A small group of younger patients ($n = 8$) was not included in this analysis. These were mainly patients with Goshgarian or 2 × 4 appliances. The frequency of pain reports (yes/no) from the youngest patients was significantly lower than from the other two groups. The middle and the older patients groups did not differ in the reports of pain frequency, but the tendency was for the patients > 16 years to report pain less frequently than the middle group ($P < 0.03$). The mean pain intensity value or time course of pain scores did not differ among the three groups. However, our data showed that the patients in the youngest age group consumed more analgesics, although not at a statistically significant level, than the older patients.

Discussion

This study consisted of 170 patients who, after the insertion of a fixed appliance, were requested to complete a series of eight questionnaires. The co-operation of the patients was extremely good. The overall response rate was 95 per cent (1292 questionnaires out of 1360) and the data can be considered as representative during the whole time of observation. The system of measuring discomfort by visual analogue scale (VAS), was found to be very appropriate. As has been reported by other authors (Huskiison, 1974; Seymour *et al.*, 1985; Oliver and

Knapman, 1985; Wilson *et al.*, 1989; Ngan *et al.*, 1994), even young children quickly grasped the concept and were able to respond to the questions.

Pain intensity and course

Pain began quickly after insertion of appliances. Kvam *et al.* (1987) reported that 95 per cent of all patients experienced pain from orthodontic appliances which is in agreement to our findings of 94 per cent of all patients complaining of discomfort within the first 24 h. Similar observations have been made by others (Wilson *et al.*, 1989; Ngan *et al.*, 1989, 1994; Jones and Chan, 1992). Out of 30 patients, 23 suffered moderate or severe discomfort in a study reported by Jones (1984), however pain intensity in our material cannot be compared directly. The mean overall or general pain intensity score never passed half of the length of the VAS in this study.

After the peak at 24 h, the curve of pain intensity showed a steady decrease, with only a small number of patients reporting high levels of pain over a long period of time. After the 5th day, the mean pain intensity score was <15 which can be considered as very mild discomfort on a scale from 0–100. For biting (incising) and chewing, pain intensity remained elevated for a longer period (Table 2). Even after 7 days, 25 per cent of patients reported having felt pain as a result of the appliances, though with a low mean intensity score (score 10). We share the opinion that pain after insertion of fixed appliances subsides to negligible levels by days 5 to 7 (Soltis *et al.*, 1971; Jones, 1984; White, 1984; Sinclair *et al.*, 1986; Kvam *et al.*, 1989; Wilson *et al.*, 1989; Ngan *et al.*, 1989, 1994; Brown and Moerenhout, 1991; Jones and Chan, 1992). This phenomenon may be the result of a significant loss of proprioceptive ability 4 days after insertion of fixed appliances (Soltis *et al.*, 1971).

Analgesic consumption

In contrast to the findings of Feinmann *et al.* (1987) who found no correlation between pain experience and analgesic consumption, our data show parallels between pain intensity score and the use of analgesics. As pain intensity peaks on the first and second day, 16 per cent and 13 per cent respectively of the patients reported the need for pain relief. By the third day only 4 per cent consumed analgesics. These results

are in agreement with those of Jones (1984) who also reported a correlation between perceived discomfort and analgesic consumption with the demand for analgesics largely finished by day 3. Ngan *et al.* (1994) reported that after one initial dose of analgesics at the moment of insertion of appliances, no patient needed additional pain relief. In the present study, approximately 20 per cent of patients reported consuming analgesics, and probably many of them on a preventive basis (Jones and Chan, 1992). Feinmann *et al.* (1987) found a correlation between the use of analgesics and anxiety. We hypothesize that by providing sufficient information to reduce anxiety it may be possible to reduce the perceived intensity of pain and/or the consumption of analgesics.

Pain sites

TMJ, lips, gingiva and tongue were not significantly affected by fixed appliances. Pain intensity scores remained within the range of very mild discomfort. Discomfort was mainly localized at the teeth. Among the soft tissues, only the cheeks were involved to a marked degree. Ulcer sites were also localized at the inner side of the cheeks. Here, pain required longer to reach a peak than at the teeth probably due to the fact that pain at the soft tissues originates mainly from mechanical contact irritation. Pain at ulcerated sites peaked on the second and third day and ebbed slowly as contact irritation continued. Kvam *et al.* (1989) reported that 61 per cent of adult patients had oral ulcers and considered this as the most annoying aspect of orthodontic treatment. Most of our patients reported no significant discomfort from mechanical irritation after 6 days.

Our data show considerably higher pain scores for anterior teeth than for posterior teeth, in agreement with the results of other investigators (Ngan *et al.*, 1989). This may be explained by the fact that during the levelling phase the anterior teeth are often more involved and that incisors have smaller root surfaces than molars. The same observation, that anterior teeth were more painful than posterior teeth, was also true for eating. It is remarkable that mean pain intensity scores after only 4 h exceeded 50 for both biting and chewing. The mean scores of 67 and 66 for pain during biting after the first and second day (Table 2) were the highest scores recorded in our study. Thus in this study,

biting and chewing were reported to be the most painful circumstances associated with fixed orthodontic appliances. Even on the fifth day, biting and chewing were still a source of considerable discomfort. Reports of discomfort at the anterior teeth remained during our entire observation period and must have, for some patients, persisted even longer.

Pain during the day/night

Jones (1984) reported pain increasing in the evening and to be more severe at night than during the day. In contrast to this, our patients reported having less discomfort in bed, when falling asleep. This finding may have been influenced by the fact that the patients answered this question the next day. However, it is in agreement with the response from most of the patients that during the day pain decreased. From the first 24 h response, for those patients reporting pain, the mean response indicated that pain reduced during the day. This perception grew stronger at each response period (data not shown). Assuming patients do not grind or clench their teeth all night, the time sleeping with the teeth within the freeway-space gives the appliances the opportunity to act more, which may lead to a perception of greater discomfort in the morning. Other investigators (Kvam *et al.*, 1989; Jones and Chan, 1992) found that 22–28 per cent of patients reported sleep disturbances due to pain from orthodontic appliances. In our sample 18 per cent reported being awakened the first night with pain from the appliance. This percentage dropped quickly and was between 1–4 per cent after the second night.

Influence on daily life

Pain from the appliance and its influence on daily life are seen as major cause of discontinuance of treatment (Brown and Moerenhout, 1991). Oliver and Knapman (1985) reported that 25 per cent of patients felt orthodontic appliances interfered with school work and social activities. Almost every patient in the present study reported some amount of interference (Table 3) but pain and discomfort affected daily life in general only to a minor degree. Parallel to the curve of pain intensity, patients felt most strongly affected by the appliance during the first two days. Influence on leisure activities, sports or social life may be considered

as negligible. Among the daily activities, eating was obviously the most affected by orthodontic appliances. The influence on the menu plan was considerable, with mean values of 60 on day 1 and 29 on day 5. These values closely mirror the pain scores from chewing (Table 2): the influence on choice of foods reflected the perceived pain on chewing.

Type of appliance

To make treatment less painful, some orthodontists may prefer to initiate treatment in one arch at a time. Our findings indicate that this procedure does not reduce perceived discomfort. Comparing a 2 × 4 appliance, a full appliance in one arch and full appliances in both arches, no statistical differences were found for reported pain frequency, general intensity of pain, pain at the teeth and analgesic consumption. Also discomfort when biting and chewing was at the same level among the groups. The only difference found was that a 2 × 4 appliance had less influence on eating, i.e. patients reported smaller changes in diet than those with appliances in both arches.

Sex

Other authors have reported no difference in the perception of pain from orthodontic appliances between males and females (Jones, 1984; Ngan *et al.*, 1989). Feinmann *et al.* (1987) in a sample of adults after oral surgery also reported that women did not report more pain or require more analgesics than men. Our data from 93 female and 77 male patients, however, indicate significant differences in the response to fixed appliances. These apparently contradictory findings may be due to several reasons. Some may be cultural; our sample was drawn from the German-speaking region of Switzerland. Other reasons may be due to differences in response sampling, e.g. the responses to the question 'Did it hurt within the last 24 h?' (yes/no), did not differ for males and females in our sample. But the analysis of mean pain intensity scores revealed that girls reported significantly greater pain intensity and consumed significantly more analgesics than males. In line with the finding of Kvam *et al.* (1987) that truancy was much higher in girls, was our observation that girls reported a higher impact on daily life from orthodontic appliances than boys. When informing patients about the side-

effects of fixed appliances, it should be borne in mind that the perception of general pain intensity, pain when eating and the influence of discomfort on daily life can, under some circumstances, differ in girls and boys.

Age

The question whether or not age has an influence on perceived pain during orthodontic therapy remains open. Here too, a critical comparison of the various studies is impossible due to differences in experimental design. In the present study, the data show that the youngest age group (10–13 years) reported pain significantly less frequently than the older groups. This result may have been influenced by the fact that the question 'Did it hurt within the last 24 h?' might be more difficult to answer by younger children when there was no pain at that moment. The group of patients older than 16 years reported a lower pain frequency than the middle group (13–16 years) although not at a significant level ($P=0.027$). Therefore, the middle age group had the highest pain frequency. This is in agreement with the report of Brown and Moerenhout (1991) who found that adolescents (14–17 years) were more vulnerable to the undesirable psychological effects of treatment and had higher levels of pain than younger or older patients. However, the mean reported pain intensity did not differ between the age groups nor did reported pain intensity for biting, chewing and analgesic consumption.

Wind instruments

The degree of interference of fixed appliances with the training of 21 wind instrument players remained relatively constant during the first 6 days, then dropped suddenly to almost zero (Table 3). In general, the more complex the appliance the greater the impact on practice. Both Goshgarian arches and fixed appliances in one arch had significantly less influence on training than appliances in both arches, the 2×4 appliance, however, was not different from appliances in two arches in this regard. The youngest wind instrument players reported the least problems with their appliances. They were also more likely to have received Goshgarian appliances. Although girls felt much more discomfort after the insertion of orthodontic appliances, the boys reported more frequently that practice with the wind instrument was very

difficult and that they had to stop for a while. It can be hypothesized that in this sample of Swiss children, the males were probably less enthusiastic in general about their training.

Conclusions

This investigation of reports of perceived pain after the insertion of orthodontic appliances revealed significant differences based on sex, age and tooth location. It confirms previous reports that pain intensity peaks within 2 days after appliance insertion and decreases to minor levels after 5 days. Although several patients reported unbearable pain, a maximum of only 16 per cent of patients consumed analgesics during the initial 24 h, at the peak of pain intensity. Pain during mastication was the most intense pain reported by our patients and it remained at elevated levels during most of the observation period. There were only minor differences in reported pain intensity regardless of the type of appliance. Except for a marked influence on the consistency of food consumed, the insertion of fixed appliances was reported to have only a transient and minor effect on the patients' daily lives.

Address for correspondence

Allen R. Firestone
Department of Orthodontics
University of Bern
Freiburgstrasse 7
CH-3010 Bern, Switzerland

Acknowledgements

The authors gratefully acknowledge the cooperation of the dentists in the Department of Orthodontics, School of Dentistry, University of Bern, Switzerland. We are especially indebted to Dr. R. Sieber, Basel, for making some of his patients available for this study. This study was helped by the technical assistance of Mrs. Margrit Stucki, who entered all the data.

References

- Brown D, Moerenhout R 1991 The pain experience and psychological adjustment to orthodontic treatment of pre-adolescents, adolescents, and adults. *American Journal of Orthodontics and Dentofacial Orthopedics* 100: 349–356
- Burstone C 1964 Biomechanics of tooth movement. In: Krause B S, Riedel R A (eds.) *Vistas in orthodontics*. Lea and Febiger, Philadelphia, pp 197–213

- Feinmann C, Ong M, Harvey W, Harris M 1987 Psychological factors influencing post-operative pain and analgesic consumption. *British Journal of Oral and Maxillo-Facial Surgery* 25: 285-292
- Huskisson E 1974 Measurement of pain. *Lancet* ii: 1127-1131
- Jones M 1984 An investigation into the initial discomfort caused by placement of an archwire. *European Journal of Orthodontics* 6: 48-54
- Jones M, Richmond S 1985 Initial tooth movement: force application and pain—a relationship? *American Journal of Orthodontics* 88: 111-116
- Jones M, Chan C 1992 The pain and discomfort experienced during orthodontic treatment. A randomised controlled clinical trial of two initial aligning arch wires. *American Journal of Orthodontics and Dentofacial Orthopedics* 102: 373-381
- Kvam E, Gjerdet N, Bondevik O 1987 Traumatic ulcers and pain during orthodontic treatment. *Community Dentistry and Oral Epidemiology* 15: 104-107
- Kvam E, Bondevik O, Gjerdet N 1989 Traumatic ulcers and pain in adults during orthodontic treatment. *Community Dentistry and Oral Epidemiology* 17: 154-157
- Ngan P, Kess B, Wilson S 1989 Perception of discomfort by patients undergoing orthodontic treatment. *American Journal of Orthodontics and Dentofacial Orthopedics* 96: 47-53
- Ngan P, Wilson S, Shanfeld J, Amini H 1994 The effect of ibuprofen on the level of discomfort in patients undergoing orthodontic treatment. *American Journal of Orthodontics and Dentofacial Orthopedics* 106: 88-95
- Oliver R, Knapman Y 1985 Attitudes to orthodontic treatment. *British Journal of Orthodontics* 12: 179-88
- Seymour R, Simpson J, Chariton J, Phillips M 1985 An evaluation of length and end-phrase of visual analogue scales in dental pain. *Pain* 21: 177-185
- Sinclair P, Cannito M, Goates L, Solomos L, Alexander C 1986 Patient responses to lingual appliances. *Journal of Clinical Orthodontics* 20: 396-404
- Soltis J, Nakfoor P, Bowman D 1971 Changes in ability of patients to differentiate intensity of forces applied to maxillary central incisors during orthodontic treatment. *Journal of Dental Research* 50: 590-596
- White L 1984 Pain and cooperation in orthodontic treatment. *Journal of Clinical Orthodontics* 18: 572-575
- Wilson S, Ngan P, Kess B 1989 Time course of the discomfort in young patients undergoing orthodontic treatment. *Pediatric Dentistry* 11: 107-110